PREFERRED RATES IN RHYTHMIC RESPONSE

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PREFERRED RATES IN RHYTHMIC RESPONSE*[1]

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This study was undertaken for the purpose of determining some of the temporal features of groups in rhythmic performance. The term rhythmic performance is taken to mean a series of recurring movements which are formed by the reactor into groups. The movement was simple tapping upon a key, with no restrictions as to the use of any particular finger, of the wrist, or of the arm. In all sections of the study but one (Section II), the method of forming groups by making the interval between them longer than the other intervals was ruled out by the instructions. Consequently, as can be seen from the reports of the reactors, the groups were formed always by accenting one element in the group, or by counting the movements, or by both (except in the last section, where an attempt was made to eliminate counting of the individual movements).

The information obtained through such a study should be of value in developing a theory of rhythm. If, for example, organic rhythms of some sort are to be looked upon as the basis for rhythmic grouping of responses, we should know what the limits of possible groups are, what their temporal relationships to one another are, and whether there is any particular time interval which is preferred as the length of a group. Is the interval between individual movements the more important factor in determining the rate of movement and so the length of the group, or does the length of the group determine the rate of the individual movements?

An attempt was made to discover if individuals have a consistently preferred rate of movement in such a simple activity as tapping upon a key, if the immediately preceding activity affects the preferred rate, if tapping in specified types of grouping would affect the rate, and what temporal relationships the different types of grouping would

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show. Would individuals who might show no preference for a certain rate in simple tapping show one in the tapping of groups, and where a preference was shown, would the determining unit be the interval between single movements or would it be the length of the group?

Historical

Seashore (11) recorded the free rhythmic tapping, for 90 sec. each, of 58 men and 59 women. The rates ranged from .30 sec. from tap to tap, to 3.5 sec. from tap to tap. Miyake (9) found that when six reactors were instructed to tap irregularly about 100 times they invariably lapsed into periods of regular tapping. At such times the rates ranged from .11 to .55 sec. per tap, with rates of from .12 to .17 the most frequent. When they tapped regularly at any rate they chose, the rates ranged from .34 to 1.35 sec. per tap. Individual differences in variability of preferred rate were marked. (His reactors tapped from 8 to 14 series each, each series at a different time.) Noiseless tapping was more irregular and slower than tapping which produced sound.

Stetson (13) reported rates ranging from .188 to .281 sec. per tap, when three reactors chose their own rates. Patterson (10) recorded the free tapping of 12 reactors for 10 sec. each. The rates chosen ranged from .25 to 1.65 sec. per tap. Braun (3) had 31 reactors tap at preferred rates on three successive days. Rates chosen ranged from .32 to 2.25 sec. per tap. The relative speed of the different reactors from day to day showed correlations from .87 to .94. Correlation between rates in different activities was low; speed in one activity was no reliable indication of speed in another.

Squire (12) gave the chosen rate of three children in uttering repeated monosyllables as from .4 to .9 sec. per sound. Wallin (14) gave the average interval between accents in spoken verse as .51 sec.

Bingham (1) studied the effect of melodic stimuli upon the rate of tapping. Evidence of a constant effect was not conclusive. Initial rates chosen by his reactors ranged from .21 to .82 sec. per tap. Wallin (15) presented metronome rates by the method of paired comparison, and found that 21 reactors chose as preferred rates ranging from .31 to 1.37 sec. from sound to sound. These limits were the extreme rates that the metronome would give. The majority chose rates faster than .7 sec. from sound to sound.

Bolton (2) reported that, in listening to objectively equal sounds occurring at equal intervals, reactors tended to group them in such a way that the preferred length of group remained relatively constant; this length he gives as being a little over 1 sec. This he believed indicated a wave of attention of relatively constant duration. However, his method was to derive the value for a given group by averaging all the rates at which that grouping was preferred, and to multiply this average by the number of elements in the group. As a result, the value given as preferred for a particular type of group was often one preferred by no one individual. Two-groups and 8-groups were preferred at the same rate by different reactors. All the rates were not, apparently, presented to each reactor. Bolton states that all reactors found some definite muscular response indispensable for bringing about a grouping. If it was restrained, the grouping disappeared.

Miner (8) found no definite relation between rate and number of elements in a group, when reactors listened to metronome sounds and grouped them as they preferred. Koffka (6) made a study very like Bolton's, using light flashes instead of sounds. He found no constant length of group; lengths varied from .65 to 5.60 sec. The number of elements in a group did not tend to increase with the rate.

Griffith (5) found no regular relation between the number of syllables in a sound unit and the rate at which it was spoken, although in general the longer units had the more rapid rates. The range of rates for any particular size of group was too great to justify the assumption that a particular rate fits a particular size of group. Miyake (9) reported no constant difference in rate between 2-groups and 3-groups in simple tapping, and the range of rates was the same in both cases.

Wallin (14) found that in spoken verse 3-syllable groups tended to be longer than 2-syllable groups. There was a tendency for the average interval between accents to increase with increasing number of syllables to a foot.

Leumann (7) discussed the relation of breathing and pulse rate to rate of other bodily activity, and attempted to show that rate of walking and rate of reading poetry varied with breathing and pulse rate. However, he gave only a little unsystematic data in support of this contention. Patterson (10) reported that in a number of

cases the rate chosen in tapping was the same as the rate of some other free activity such as walking, breathing, swaying, or nodding regularly, or that one rate was a simple fraction or multiple of the other. Seashore (11) concluded that pulse and respiration determined the rates chosen by his reactors, since those rates fell within the range of rates of pulse or breathing, or were simple fractions or multiples of them. He did not take simultaneous records of pulse, breathing, and tapping from any one reactor.

Coleman (4) reported a definite correspondence between bodily movements such as walking or flexing the arm at a freely chosen rate and heart rate or breathing rate.

Apparatus and General Procedure

A double contact key, pivoted at the center, was used. Felt padding was placed under one contact which was not used. The other contact was under the button on which the finger rested for the tapping. There was a click on the down-stroke of each tapping movement. The taps were recorded by an electromagnetic pen-marker; a second marker, operated through a relay by a Jacquet chronometer, wrote a time line in fifths of a second beside the line which recorded the taps. An electromagnetic counter was in series with the tapping key. The key was placed on a table in a room at one side of the laboratory. The recording apparatus was in another room at the other side of the building. The reactor could hear the ordinary daytime sounds of the building. He sat, while tapping, in any position he chose.

There were 12 reactors used (5 men and 7 women), not all of them in each section. They performed at any time of the day that suited them best. All were graduate students in the department of psychology. Seven had had some musical training, varying in amount from 6 months on the mandolin to 10 years of piano and voice. Those who had had musical training were reactors *B, C, E, G, H, K,* and *L.* No significant differences in performance were noticed between those with and those without musical training.

As each reactor entered the room he was given a sheet of typewritten instructions for that day. The door was closed and he was left alone. A buzzer signalled him to begin; after 100 taps he was signalled to stop. A pause of one minute followed, and the next series of 100 taps began. Comments were recorded at the end of

the sitting. It was necessary to assume that the reactor was actually tapping the groups when they were required. The grouping was usually evident in the sound of the tapping; one element in the group was usually accented.

All records except those of Section II were measured by taking consecutive groups of 10 taps, measuring to the nearest 10th of a second the duration of each 10, and then taking the average of the 10 groups of 10, and the mean variation. The tapping was usually regular and the mean variation small.

Section I. Rates chosen in regular tapping without specified grouping, and with "faster" and "slower" rates alternating with "most satisfactory" rates.

Ten reactors took part in this section. There were four different instruction sheets. The first one read as follows:

> 1. Tap regularly (making the intervals between taps equal) at any rate you find most satisfactory.
> 2. Tap regularly at a rate that seems to you a little faster than the rate you would choose as most satisfactory.
> 3. Tap regularly at a rate that seems to you a little slower than the rate you would choose as most satisfactory.
> 4. Tap regularly at the rate you find most satisfactory.
>
> The buzzer will give you the signal for the beginning and end of each series.

The other three sheets differed from this one only in the order in which the four different series followed one another. On the second sheet the order was "slower," "most satisfactory," "faster," "most satisfactory." On the third sheet it was "faster," "most satisfactory," "slower," "most satisfactory." On the fourth it was "most satisfactory," "slower," "faster," "most satisfactory." Each reactor performed one of these orders on a given day. The next time, always on a different day, he followed a different order, and so on, in rotation. Although not all reactors did the same number of series, the number of "most satisfactory" series tapped just after a "faster" series by any one reactor never differed by more than one from the number of "most satisfactory" series tapped just after a "slower" series. The same holds for the number of "most satisfactory" series tapped first and last on a given day.

All 10 reactors completed 5 days of performance; 9 of them went

TABLE 1

RATES* OF REACTORS IN SECTION I; REGULAR, UNGROUPED TAPPING

Day									I	S	F	II
						Reactor *A*						
1		I	5.7	S	13.9	F 2.2	II	7.3	5.7	13.9	2.2	7.3
2	(1)	F	2.0(.2)	I	5.8	S 6.5	II	3.8	5.8	6.5	2.0	3.8
3	(1)	S	3.8(.2)	I	2.3	F 1.7	II	2.2	2.3	3.8	1.7	2.2
4	(1)	I	2.0	F	1.5	S 3.9	II	2.0	2.0	3.9	1.5	2.0
5	(1)	I	2.0	S	2.9	F 1.4	II	2.3	2.0	2.9	1.4	2.3
6	(1)	F	1.8	I	2.0	S 2.6	II	2.0	2.0	2.6	1.8	2.0
7	(2)	S	3.1	I	2.4	F 1.7	II	2.2	2.4	3.1	1.7	2.2
8	(1)	I	2.6	S	3.6	F 1.8	II	2.7	2.6	3.6	1.8	2.7
9	(1)	F	1.7	I	2.4	S 3.1(.2)	II	2.4	2.4	3.1	1.7	2.4
10	(1)	S	3.6	I	2.5	F 1.8	II	2.3	2.5	3.6	1.8	2.3
11	(5)	I	2.4	F	1.7	S 2.6	II	2.0	2.4	2.6	1.7	2.0
						Reactor *B*						
1		F	3.8(.3)	I	3.5(.2)	S 5.5	II	3.2(.2)	3.5	5.5	3.8	3.2
2	(1)	F	2.7	I	3.5	S 4.6	II	3.4	3.5	4.7	2.7	3.4
3	(1)	S	6.2	I	3.8(.3)	F 2.7(.2)	II	3.4	3.8	6.2	2.7	3.4
4	(1)	I	2.9	F	2.2	S 3.5	II	2.9	2.9	3.5	2.2	2.9
5	(1)	I	3.6	S	5.3	F 3.0	II	3.4	3.6	3.5	2.2	3.4
6	(3)	F	2.7	I	3.4	S 4.8	II	3.4	3.4	4.8	2.7	3.4
7	(1)	S	4.9	I	3.3	F 2.6	II	3.1	3.3	4.9	2.6	3.1
8	(3)	I	3.9	S	4.7(.3)	F 2.9	II	3.6	3.9	4.6	2.9	3.6
9	(1)	S	5.5	I	3.6	F 2.7	II	3.2	3.6	5.5	2.7	3.2
10	(3)	I	3.9	F	3.0	S 4.5	II	3.4	3.9	4.5	3.0	3.4
11	(1)	I	3.9	S	5.1	F 2.7	II	3.4	3.9	5.1	2.7	3.4

*Rates are given in sec. per 10 taps. Symbol I signifies first "most satisfactory" rate on a given day; II signifies second "most satisfactory" rate on that day; F signifies "faster" rate; S signifies "slower" rate. Daily order reads from left to right. Mean variations are .1 except where indicated in parentheses after a number. Figures in parentheses in the "day" column indicate the number of days that elapsed between the performance of the series in that row and the performance of the preceding series. In last four columns the rates are arranged in columns according to type, without regard to daily order.

TABLE 1 (*continued*)

Day									I	S	F	II
						Reactor *C*						
1		I	9.2(.3)	F	5.9(.2)	S	11.4(.3)	II	8.6(.2)	9.2	11.4	5.9	8.5
2	(1)	F	5.6	I	8.6	S	12.8(.4)	II	8.7(.2)	8.6	12.8	5.4	8.7
3	(1)	S	12.0(.5)	I	8.7	F	5.4(.2)	II	8.3	8.7	12.0	5.6	8.3
4	(1)	I	7.6	S	10.1(.2)	F	6.2	II	8.2	7.6	10.1	6.2	8.2
5	(1)	I	3.1	S	4.7(.4)	F	1.8	II	4.0	3.1	4.7	1.8	4.0
6	(1)	F	1.9	I	3.2(.2)	S	4.7	II	3.3	3.2	4.7	1.9	3.3
7	(2)	S	5.4	I	3.8	F	2.1	II	3.5	3.8	5.4	2.1	3.5
8	(1)	I	3.4(.3)	S	4.1(.2)	F	2.0	II	2.8	3.4	4.1	2.0	2.8
9	(2)	F	1.9	I	3.0	S	4.0	II	2.8	3.0	4.0	1.9	2.8
10	(1)	S	4.2	I	3.0(.2)	F	1.9	II	2.6	3.0	4.2	1.9	2.6
11	(4)	I	2.6	F	1.8	S	3.3	II	2.4	2.6	3.3	1.8	2.4
						Reactor *D*						
1		I	2.7	S	5.9(.3)	F		II	2.7	2.7	5.9		2.7
2	(1)	F	2.0	I	2.4	S	3.6	II	2.6	2.4	3.6	2.0	2.6
3	(1)	S	3.5(.2)	I	2.5(.2)	F	1.9	II	2.4	2.5	3.5	1.9	2.4
4	(1)	I	2.3	F	2.0	S	3.3	II	2.5	2.3	3.3	2.0	2.5
5	(1)	I	2.5	S	3.5(.2)	F	1.9	II	2.5	2.5	3.5	1.9	2.5
6	(1)	F	2.0	I	2.5	S	3.5(.2)	II	2.6	2.5	3.5	2.0	2.6
7	(2)	S	3.1	I	2.5	F	1.8	II	2.4	2.5	3.1	1.8	2.4
8	(2)	I	2.6	S	3.8	F	2.1	II	2.6	2.6	3.8	2.1	2.6
9	(1)	F	1.9	I	2.4	S	3.1	II	2.6	2.4	3.1	1.9	2.6
10	(1)	S	3.5	I	2.6	F	2.0	II	2.6	2.6	3.5	2.0	2.6
11	(4)	I	2.5	F	1.9	S	3.1	II	2.5	2.5	3.1	1.9	2.5
						Reactor *E*						
1		S	11.7	I	7.9	F	4.8	II	7.8(.2)	7.9	11.7	4.8	7.8
2	(4)	F	3.2	I	7.1	S	10.2	II	8.7(.2)	7.1	10.2	3.2	8.7
3	(2)	I	9.2(.2)	S	11.4	F	6.3	II	10.9	9.2	11.4	6.3	10.9
4	(2)	I	5.3	F	3.2	S	6.6(.3)	II	5.9	5.3	6.6	3.2	5.9
5	(5)	I	4.3	S	6.3	F	3.1	II	4.0	4.3	6.3	3.1	4.0
6	(8)	F	3.7	I	4.8	S	8.0	II	4.9	4.8	8.0	3.7	4.9
7	(1)	S	7.7	I	4.9	F	3.8	II	5.5	4.9	7.7	3.8	5.5
8	(1)	I	6.1	F	3.9(.2)	S	7.8	II	5.7(.2)	6.1	7.8	3.9	5.7
9	(2)	I	6.4	S	8.6(.2)	F	4.4	II	6.5(.2)	6.4	8.6	4.4	6.5
10	(2)	I	5.1	F	3.2(.4)	S	8.4	II	5.5	5.1	8.4	3.2	5.5
11	(5)	F	3.4	I	5.2	S	7.2(.2)	II	4.4(.2)	5.2	7.2	3.4	4.4

TABLE 1 (*continued*)

Day								I	S	F	II
					Reactor *F*						
1	I	2.2	S	10.2(.4)	F 1.5	II	2.0	2.2	10.2	1.5	2.0
2 (6)	F		I	2.5(.2)	S 5.6(.3)	II	3.2(.2)	2.5	5.6		3.2
3 (1)	S	9.4(.6)	I	5.2(.2)	F 2.6	II	3.1(.3)	5.2	9.4	2.6	3.1
4 (1)	S	7.9	I	4.4(.2)	F 2.2(.2)	II	2.5(.2)	4.4	7.9	2.2	2.5
5 (5)	I	4.0(.2)	F	2.2(.2)	S 7.0(.3)	II	5.2(.2)	4.0	7.0	2.2	5.2
6 (1)	I	2.4	S	6.6	F 3.0(.8)	II	3.3(.4)	2.4	6.6	3.0	3.3
7 (1)	F	2.0	I	3.3(.2)	S 5.5(.2)	II	4.7	3.3	5.5	2.0	4.7
8 (13)	I	6.6(.2)	F	4.4(.2)	S 7.6(.2)	II	5.2(.2)	6.6	7.6	4.4	5.2
9 (2)	I	6.0	S	7.7(.3)	F 4.0(.2)	II	5.1(.2)	6.0	7.7	4.0	5.1
10 (4)	F	3.3	I	5.7	S 9.4	II	6.0	5.7	9.4	3.3	6.0
					Reactor *G*						
1	F	7.1(.5)	I	10.9	S 15.4(.4)	II	11.3	10.9	15.4	7.1	11.3
2 (2)	I	10.4	S	12.7	F 4.5	II	8.7	10.4	12.7	4.5	8.7
3 (1)	F	4.1	I	6.8	S 11.0	II	8.4	6.8	11.0	4.1	8.4
4 (1)	S	12.1	I	9.4	F 5.7	II	7.7	9.4	12.1	5.7	7.7
5 (3)	I	7.0	S	11.2(.3)	F 5.5	II	7.7	7.0	11.2	5.5	7.7
6 (1)	F	4.9	I	7.8	S 12.0	II	9.2	7.8	12.0	4.9	9.2
7 (1)	S	11.1	I	8.0	F 5.5	II	7.9	8.0	11.1	5.5	7.9
8 (12)	I	6.9(.2)	F	4.7	S 7.9	II	6.5(.2)	6.9	7.9	4.7	6.5
9 (1)	I	6.6	F	4.2	S 9.8(.2)	II	7.3	6.6	9.8	4.2	7.3
10 (4)	I	6.8	S	10.8(.4)	F 5.4	II	7.7	6.8	10.8	5.4	7.7

TABLE 1 (*continued*)

Day									I	S	F	II
						Reactor *H*						
1		F	2.1	I	2.8	S 4.7(.4)	II	3.7	2.8	4.7	2.1	3.7
2	(1)	F	3.0(.2)	I	4.4	S 6,0(.4)	II	5.5(.2)	4.4	6.0	3.0	5.5
3	(1)	S	7.2(.3)	I	3.9	F 3.4	II	4.0	3.9	7.2	3.4	4.0
4	(1)	I	3.5	F	2.9	S 4.0(.2)	II	3.7	3.5	4.0	2.9	3.7
5	(3)	I	3.5	S	5.5	F 2.3	II	3.8	3.5	5.5	2.3	3.8
6	(2)	F	2.8	I	3.3	S 5.7(.2)	II	3.4	3.3	5.7	2.8	3.4
7	(1)	S	5.4(.2)	I	3.9	F 2.9	II	3.4	3.9	5.4	2.9	3.4
8	(1)	I	3.2	S	5.2(.3)	F 3.0(.2)	II	3.7(.2)	3.2	5.2	3.0	3.7
9	(3)	1	3.8	F	3.1	S 4.9(.2)	II	3.8	3.8	4.9	3.1	3.8
						Reactor *I*						
1		I	9.1	S	15.8(.2)	F 4.3(.3)	II	6.5	9.1	15.8	4.3	6.5
2	(2)	F	4.3	I	6.2	S 9.4	II	6.6	6.2	9.4	4.3	6.2
3	(1)	S	10.8	I	7.7	F 5.0	II	6.8	7.7	10.8	5.0	6.8
4	(1)	I	6.2	F	4.4	S 7.6	II	5.5	6.2	7.6	4.4	5.5
5	(3)	I	5.5	S	7.7	F 3.0	II	5.5	5.5	7.7	3.0	5.5
6	(2)	F	3.5	I	5.7	S 8.0	II	5.5	5.7	8.0	3.5	5.5
7	(1)	S	6.2	I	4.9	F 3.2(.3)	II	5.1	4.9	6.2	3.2	5.1
8	(1)	I	5.9	S	8.4	F 3.6	II	6.3	5.9	8.4	3.6	6.3
						Reactor *J*						
1		I	10.3(.3)	S	16.4(.4)	F 7.6	II	12.1(.2)	10.3	16.4	7.6	12.1
2	(1)	F	5.3	I	8.4(.2)	S 14.7(.2)	II	10.3(.2)	8.4	14.7	5.3	10.3
3	(1)	S	17.5(.4)	I	15.7(.2)	F 7.9(.4)	II	13.1(.3)	15.7	17.5	7.9	13.1
4	(4)	I	13.8(.2)	F	7.9(.2)	S 15.7(.3)	II	13.1(.3)	13.8	15.7	7.9	13.1
5	(1)	I	13.0(.3)	S	16.7(.7)	F 9.2(.2)	II	13.8(.3)	13.0	16.7	9.2	13.8

TABLE 2
DISTRIBUTION OF "MOST SATISFACTORY" RATES IN SECTION I
Rate in seconds per 10 taps

Reactor	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	Total
A	18	1		2		1								22
B	2	20												22
C	5	8	1			1	6	1						22
D	22													22
E			6	7	3	3	1	1	1					22
F	5	5	3	4	3									20
G					5	7	3	2	2	1				20
H	1	14	2	1										18
I			1	7	6	1		1						16
J							1		2		1	5	1	10
Totals	53	48	13	21	17	13	11	5	4		1	5	1	

TABLE 3
DISTRIBUTION OF ALL THREE TYPES OF RATES IN SECTION I

Reactor	Type	Rate in seconds per 10 taps																
		1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	Totals
	S		3	6			1							1					11
A	M		18	1		2		1											22
	F	9	2																11
	S			2	5	3	1												11
B	M		2	20															22
	F		9	2															11
	S			1	5	1					1	1	2						11
C	M		5	8	1			1	6	1									22
	F	5	2			3	1												11
	S			10		1													11
D	M		22																22
	F	5	5																10
	S						2	3	3		1	2							11
E	M				6	7	3	4		1	1								22
	F			8	2		1												11
	S					2	1	4		2	1	1							11
F	M		5	4	3	5	3												20
	F	1	4	2	2														9
	S							1		1	1	3	3			1			10
G	M						5	7	3	2	2	1							20
	F				5	4		1											10
	S				3	4	1	1											9
H	M		1	14	2	1													18
	F		5	4															9

TABLE 3 (*continued*)

	S						1	2	2	1	1					1				8
I	M				1	7	6	1		1										16
	F			4	3	1														8
	S														1	1	2	1		5
J	M								1		2		1	5		1				10
	F					1		3		1										5
Totals	S	0	3	19	13	11	7	11	5	4	5	7	5	1	1	3	2	1		98
	M	0	53	48	13	21	17	14	10	5	5	1	1	5		1				194
	F	20	27	20	12	9	2	4	0	1										95

S—"Slower."
M—"Most satisfactory."
F—"Faster."

on to complete 8 days, 8 of them completed 9 days, 7 completed 10 days, and 5 of them completed 11 days. On each day two "most satisfactory" series were tapped, and one each of "faster" or "slower" series. Each reactor did not tap on consecutive days, and the total number of days elapsed from first to last performance varied from 7 days to 34 days.

Table 1 gives the rates of each reactor for each day, in the order in which they were done.

1. *Individual Differences in Rates Chosen As Most Satisfactory, and in the Constancy of These Choices Over a Number of Days.* Table 2 gives the distribution of rates of all series tapped as most satisfactory. The rates are given in seconds per 10 taps. If the total range is divided into intervals of one second, it is seen that there are "most satisfactory" rates in every class interval from 1.0-1.9 sec. to 14.0-14.9 sec. The table shows the difference in range of rates chosen by different individuals as well as the difference in the frequency with which different individuals chose closely similar rates from day to day.

Table 3 shows for comparison the distribution of each of the three types of rates, "slower," "faster," and "most satisfactory."

The range of rates varied from .4 sec. per 10 taps for Reactor *D* to 6.9 sec. per 10 taps for Reactor *E*. The range of rates for all reactors is given in Table 4.

TABLE 4

Reactor	Seconds per 10 taps	Range	Number of "most satisfactory" series tapped
A	2.0- 7.3	5.3	22
B	2.9- 4.0	1.1	22
C	2.4- 9.2	6.8	22
D	2.3- 2.7	.4	22
E	4.0-10.9	6.9	22
F	2.0- 6.6	4.6	20
G	6.5-11.3	4.8	20
H	2.8- 5.5	2.7	18
I	4.9- 9.0	4.1	16
J	8.4-14.3	5.9	10

The row in Table 2 giving the distribution of rates for Reactor *C* reveals an unusual and definitely bimodal distribution, with rates grouped at either end of the total range and a gap between them.

This reactor stated that after she had been tapping for several days she realized that she had been tapping much more slowly than she really wanted to, and from then on she tapped much faster. Reactor *D* showed the most striking regularity in her tapping rates from day to day. Since they are all relatively fast, it might be thought that it was the result of her tapping as fast as she could all the time, but inspection of her "faster" rates shows that they were all actually faster than her "most satisfactory" rates.

The main points to be seen in this table of "most satisfactory" rates are that certain reactors were much less variable than others in the rates they chose from day to day, that each reactor, even the most variable, chose rates in only a restricted section of the total range of rates chosen by the group, and that even among those showing a relatively wide range of chosen rates there were some who showed an apparent preference for a narrower range of rates, the size of their total range being due to a relatively few extreme cases.

The range of rates chosen by this group is rather similar to previously reported rates for the same activity. These are: Seashore, 3.0 to 35.0 sec. per 10 taps; Miyake, 3.3 to 13.5 sec. per 10 taps; Stetson, 1.9 to 2.8 sec. per 10 taps; Bingham, 2.3 to 8.0 sec. per 10 taps; Patterson, 2.5 to 10.3 sec. per 10 taps; Braun, 2.5 to 22.5 sec. per 10 taps.

Table 5 makes possible a comparison of the ranges of the "faster," "slower," and the two daily "most satisfactory" rates.

TABLE 5

RANGES OF THE THREE DIFFERENT TYPES OF RATES*

Reactor	Most satisfactory	Range	Faster	Range	Slower	Range
A	2.0- 7.3	5.3	1.4-2.2	.8	2.6-13.9	11.3
B	2.9- 3.9	1.0	2.2-3.7	1.5	3.5- 6.2	2.7
C	2.4- 9.2	6.8	1.8-6.2	4.4	3.3-12.8	9.5
D	2.3- 2.7	.4	1.8-2.1	.3	3.0- 5.9	2.9
E	4.0-10.9	6.9	3.1-6.3	3.2	6.3-11.7	5.4
F	2.0- 6.6	4.6	1.5-4.4	2.9	5.5-10.2	4.7
G	6.5-11.3	4.8	4.1-7.1	3.0	7.9-15.4	7.5
H	2.8- 5.5	2.7	2.1-3.4	1.3	4.0- 7.2	3.2
I	4.9- 9.0	4.1	3.0-5.0	2.0	6.2-15.8	9.6
J	8.4-14.3	5.9	5.3-9.2	3.9	14.7-17.5	2.8

*Rates are in seconds per 10 taps.

It will be seen that the range for the "slower" rates was greater than that of the others 8 times out of 10. In the two cases where it was not, the range of the "most satisfactory" rates was greatest. The range of the "faster" series was least in every case but one. In that case (Reactor *J*) it was the "slower" series which had the smallest range. This reactor consistently chose slower rates as most satisfactory than did the rest of the group.

There were seven reactors among whose "most satisfactory" rates there were rates which fell in the region of the total range where rates were never tapped in response to the instruction to tap faster or more slowly than was most satisfactory. It is interesting to observe for each reactor what proportion of all his "most satisfactory" rates fell in this region of no overlapping. Table 6 shows for each reactor the number and proportion of "most satisfactory" rates which fell in a region of his total range of rates where "faster" or "slower" series were never tapped.

TABLE 6

Reactor	1 Number of "most satisfactory" series which fell in region of no overlapping	2 Total number of "most factory" series done	3 Percentage 1 is of 2	4 Range of no overlapping region in seconds	5 Range of all "most satisfactory" rates	6 Percentage 4 is of 5
D	22	22	100	.4	.4	100
H	12	18	67	.6	2.7	23
A	11	22	50	.4	5.3	8
I	9	16	56	1.2	4.1	29
J	9	10	90	5.1	5.9	86
G	6	20	30	.8	4.8	17
F	5	20	25	1.0	4.6	22

Table 6 shows, for instance, that Reactor *D* always tapped for her "faster" series a rate which was faster than any rate she ever tapped for her "most satisfactory" series, and likewise she always tapped for her "slower" series a rate which was slower than any rate she ever tapped for her "most satisfactory" series. Reactor *H* tapped 67 per cent of all his "most satisfactory" series at rates which fell within a region of his total range in which he never tapped

"faster" or "slower" rates, and this region constituted only 23 per cent of his total range. Similarly for the other five reactors.

In the case of Reactors *B, C,* and *E,* the range of "slower" and "faster" rates overlapped completely the range of "most satisfactory" rates. In other words, every "most satisfactory" rate lay in a region of rates which at some time or other was considered to be slower or faster than the most satisfactory rate. In the case of two of these reactors (*B* and *C*), the ranges of the "faster" and "slower" rates overlap one another. One of these reactors (*C*) is the reactor with the bimodal distribution of "most satisfactory" rates, mentioned before. The other (*B*) was one of those who showed the least variability in range of "most satisfactory" rate.

Inspection of those figures in Table 1 which show the number of days elapsed between each individual's separate performances reveals that these performances were spread over a much greater number of days in the case of Reactors *E, F,* and *G* than in the case of the other reactors. If we omit Reactor *C,* whose deliberate change of preferred rate during the course of her performances has been referred to, it appears that these same reactors, *E, F,* and *G,* were also the ones with the greatest diversity of preferred rates.

2. *The Effect of Preceding "Faster" or "Slower" Series Upon the Rate of the "Most Satisfactory" Series.* Does the "most satisfactory" rate, if tapped just after a "faster" or "slower" series, tend to be slower or faster for that reason? Taking the group as a whole, and leaving out of account the four different daily orders in which the rates were done, we see that of the 78 "most satisfactory" series which followed a "faster" series, 48, or 69 per cent, were faster than the other "most satisfactory" series done on the same day. Of the 68 "most satisfactory" series which followed a "slower" series, 44, or 65 per cent, were slower than the other "most satisfactory" series for that day.

If we take the different orders separately, we see that when the order was "most satisfactory," "slower," "faster," "most satisfactory," which order was done 28 times altogether, the "most satisfactory" series which followed the "faster" series was faster than the other "most satisfactory" series 11 times out of 28, or 39 per cent. The order "most satisfactory," "faster," "slower," "most satisfactory," was done 18 times. The "most satisfactory" series following the "slower" was slower than the other "most satisfactory" series 7 times out of 18, or 39 per cent.

The order "faster," "most satisfactory," "slower," "most satisfactory," was done 27 times. The "most satisfactory" series which followed the "slower" was slower than the "most satisfactory" series which followed the "faster" 18 times out of 27, or 67 per cent. The corresponding figures for the order "slower," "most satisfactory," "faster," "most satisfactory," are 19 out of 23, or 83 per cent. Taking both of these orders together, it appears that 37 times out of 50, or 74 per cent, the "most satisfactory" series following a "faster" or a "slower" series was faster or slower, respectively, than the other "most satisfactory" series on the same day.

When the rates of individual reactors are inspected, it is seen that no one reactor always tapped more slowly in his "most satisfactory" series, just after having done a "slower" series, than in his other "most satisfactory" series for the same day. The same is true for the "most satisfactory" series which followed "faster" series. Certain reactors, however, did appear to be definitely influenced in this way. For example, in the two orders, "faster," "most satisfactory," "slower," "most satisfactory," and "slower," "most satisfactory," "faster," "most satisfactory," Reactors *F* and *G* tapped the series following the "slower" more slowly than that following the "faster" on all of the five days on which they did these orders. Reactor *D* did this on five of six days, Reactor *H* on four of five days, and Reactor *J* on both of two days.

When the order was "most satisfactory," "slower," "faster," "most satisfactory," Reactor *B* tapped the last "most satisfactory" series faster than the first on three days out of three, and Reactors *D* and *F*, again, did so on two days out of three.

When the order was "most satisfactory," "faster," "slower," "most satisfactory," Reactor *H* tapped the last series more slowly than the first on both days on which he did this order.

It is conceivable that the "slower" series may have influenced the succeeding series in the opposite rather than in the same direction; similarly for the "faster" series. In the order "faster," "most satisfactory," "slower," "most satisfactory," Reactors *A* and *B* tapped the last "most satisfactory" series faster than the first on three days out of three. One of these reactors (*B*) had shown the opposite tendency in another order. In the order "slower," "most satisfactory," "faster," "most satisfactory," Reactor *E* tapped the last "most satisfactory" series more slowly than the first on two days out

of two. In the other two orders, no reactor showed a tendency to be quickened by "slower" or slowed by "faster" series.

No general statement can be made with regard to the effect of the "faster" and "slower" series on the succeeding "most satisfactory" series. Statements must be restricted to individual cases. Certain reactors do seem to have been influenced rather consistently; others do not. Reactor *D*, one of the former, was the reactor with the least variability from day to day in choice of "most satisfactory" rate, and was the one among whose range of different types of rates there was no overlapping.

3. *Comparison of the Variability of the Three Types of Series.* Since the rates were measured to the nearest 10th of a second, and the mean variation of the averages of the different series was usually of a smaller order than a 10th of a second, few significant differences in variability among the different series could be detected within the limits of these measurements. However, it may be said that when the mean variation was greater than a 10th of a second, it usually belonged to a "slower" series. Inspection of the individual records shows that for every reactor but one, "slower" rates were the most variable.

4. *Reports of Reactors.* One reactor (*E*) stated that once in a while she tapped as an accompaniment to some tune that was running through her head. Reactor *D* said that it was very difficult to keep from tapping some rhythmic pattern. None except Reactor *E* could say why a particular rate was chosen as most satisfactory on a given day. Reactor *B* was very doubtful that any rate was really more satisfactory than another. This reactor was one of the least variable from day to day in rate of "most satisfactory" series, but was one of those whose range of "faster" and "slower" rates completely overlapped the range of "most satisfactory" rates. Reactor *H* said that it was definitely more pleasant to tap the "most satisfactory" rate. He said on one occasion that any rate tended to become satisfactory; when he found this happening during a series which was supposed to be faster or slower than most satisfactory, he varied the rate to make it unsatisfactory again. For this reason he expected his "slower" and "faster" rates to be more variable within any one series. The average mean variation of his "slower" series was .3 sec.; of each of the other three series, .1 sec.

All reactors reported using the index finger of the right hand

almost constantly. Several changed occasionally for short periods to another finger.

Section II. Relative Duration of Different Groups When Taps Were Grouped by Any Method. The general procedure for this section was the same as for Section I. The instructions to the reactors were different. The 10 reactors who took part in the preceding section were used in this one, and a new reactor was added. The different series of tappings were done in three different orders. The 11 reactors were divided into three groups of four, four, and three. Each group went through the series in a different one of the three orders. The three reactors whose median preferred rates in Section I were fastest were each put into a different group, the next fastest three were likewise divided, and the next fastest three. The slowest was put into the first group, and the new reactor into the second.

The instructions for the first group were as follows:

> You are to tap seven series. You will be signalled to start and to stop each series. You may choose any rate of tapping you wish. The taps in each series are to be grouped, a different type of grouping for each series. By grouping is meant this: you are to feel each two, three, or whatever number of taps is called for, as a unit. You may use any method you choose to bring this about.
>
> The following groups are to be tapped in the order given:
>
> | | |
> |---|---|
> | First series: | Groups of 2 |
> | Second series: | Groups of 3 |
> | Third series: | Groups of 4 |
> | Fourth series: | Groups of 5 |
> | Fifth series: | Groups of 6 |
> | Sixth series: | Groups of 7 |
> | Seventh series: | Groups of 8 |

The instructions for the second and third groups of reactors were the same as this, except that for the second group the order was groups of 8, 7, 6, 5, 4, 3, 2. For the third group the order was groups of 5, 4, 6, 3, 7, 2, 8. Each series consisted of 100 taps, and there was a one-minute pause between each series, as before. Each reactor did one order of seven series.

All but one of the reactors separated the groups by relatively long pauses; a number of them also made certain taps longer than

the others. For this reason the records did not yield satisfactory measures of rate, since the tapping was not regularly spaced. It was not possible to measure accurately the intervals between individual taps. The average duration of 10 groups of 10 taps would not give a true picture of the actual rates tapped, when the taps constituted a rhythmic pattern. For this reason only the actual duration of the specified groups was measured, and the average duration and mean variation of the average of the different groups were determined.

TABLE 7

DURATION OF GROUPS IN SECTION II; GROUPING TAPS BY ANY METHOD

Figures are the average duration of the groups, measured from the first tap of one group to the first of the next. Time is in seconds. Mean variations are .1 except where indicated in parentheses after a number.

Reactor	2-groups	3-groups	4-groups	5-groups	6-groups	7-groups	8-groups
	Reactors in group 1; order of groups: 2,3,4,5,6,7,8						
H	.8	.9	1.2	1.5	1.8(.0)	2.2(.2)	2.5
D	.6	1.0	1.5(.0)	1.8	2.5(.0)	2.2(.2)	2.7(.3)
J	1.4	2.2	1.8	2.8(.0)	3.8	4.4	5.0
E	.6	.9(.0)	1.0	1.5	1.7	1.7	2.1
	Reactors in group 2; order of groups: 8,7,6,5,4,3,2						
A	1.1(.2)	1.4(.4)	2.5(.3)	4.2(.4)	4.1(1.0)	4.9(.6)	4.5(.7)
F	.9(.0)	1.2(.0)	1.1	1.2(.0)	1.4(.0)	2.0	2.2
G	1.2(.0)	1.7	1.9	2.5(.0)	2.4	2.8	2.9
K	.8(.2)	.9	1.1	1.4	1.7(.2)	2.1	2.5
	Reactors in group 3; order of groups: 5,4,6,3,7,2,8						
B	.9	1.3(.2)	1.6	1.6(.0)	2.1	2.0(.0)	2.2
C	1.1	1.5	1.7	2.0	2.4	2.7(.0)	3.0
I	.9	1.4	2.1	1.9	2.2	2.0(.0)	2.6

Table 7 gives the average length of group for each type of grouping for every reactor. On the records of all but one reactor the grouping was visible because of the pause between groups. The general tendency was clearly to make longer the groups which had more elements. This was true throughout of four reactors. If the 5- and 7-groups are eliminated, it was true throughout for 9 of the 11 reactors.

There were a number of exceptions. The 3-group was twice longer than the 4-group, the 4-group was in one instance longer than the 5-group, the 5-group was twice longer than the 6-group, and the 6-group was longer than the 7-group three times. In all

cases but these, the general tendency, to make the larger groups longer, held.

The groups were not simple multiples of one another, however. The 4-group was in only three instances (Reactors *A*, *D*, and *I*) twice as long as the 2-group; the 6-group was in only two instances (Reactors *A* and *D*) three times as long as the 2-group; and the 8-group was in only two instances (Reactors *A* and *D*) four times as long as the 2-group. These comparisons are all between average durations of groups, of course.

There was evidently a tendency to increase the rate as the number of elements in the group increased, taking the group as a whole. Six reactors, however, made their 8-groups as much as or more than twice as long as their 4-groups. Three reactors (*A*, *D*, and *H*) made their 6-groups more than twice as long as their 3-groups.

These results indicate that there was no unit-length of group into which the groups having different numbers of elements were fitted. The temporal relationship between the groups is not a simple or a constant one.

Reactor *I* said that she always counted an extra tap over the number prescribed, to divide the groups, except when she was doing the 5-groups. This is probably why her 5-groups were shorter than her 4-groups.

All reactors reported that they counted in most of the series, and a number of them in all series. Several found it unnecessary in the 2-, 3-, and 4-groups. Reactor *H* was the only one who did not separate the groups by a pause; he counted regularly.

Section III. Relative Rates of Different Types of Groups, When Equal Intervals between Taps Were Required, and Reactors Chose Any Rate. The 11 reactors of the preceding section, and one new reactor, took part in this section. There were three new sets of instructions. Eleven reactors did all three of the new sets; the other one did two of them.

The first instruction sheet was as follows:

> Tap at a regular rate, making the intervals between taps equal, but think of the taps as being in groups. There will be several series of taps; each series will have a specified type of grouping. You will be signalled to start and to stop each series. Choose any rate you wish for each series.

The following series are to be done in the order given:	
First series:	Groups of 2
Second series:	Groups of 3
Third series:	Groups of 4
Fourth series:	Groups of 5
Fifth series:	Groups of 6
Sixth series:	Groups of 7
Seventh series:	Groups of 8

The other two sets of instructions differed only in the order of the various series of groupings. The order on the second sheet was groups of 8,7,6,5,4,3,2; on the third, groups of 4,6,5,7,3,8,2.

Table 8 gives in detail the rates tapped by each reactor in each of the orders. Table 9 compares the rates of each series of groups with each series of smaller groups for each order separately, and Table 10 gives the same comparison for all three orders combined.

These figures show that no reactor tapped faster without exception in his series of larger groups than in his smaller. Some reactors did so, for certain types of groups throughout all three orders, when these groups are compared with certain others only. Reactor *A* always tapped 3-groups faster than 2-groups, and 8-groups faster than any other. Reactor *B*, in every instance but one, tapped 8-groups faster than any other. Inspection of the tables will show similar results for some other reactors with regard to selected groups.

If, taking all three orders together, the number of times a given series of groups could have been faster than series having smaller groups is determined, and the proportion is taken of series that actually were faster than the series having smaller groups, it will be seen (Table 10) that for only three reactors does this proportion reach as high as 2/3. For five of the reactors it is below 1/2.

When the three different orders are taken separately (Table 8), the order in which the order of groups was 2,3,4,5,6,7,8 is seen to have the largest proportion of instances in which a given series of groups was faster than the series having smaller groups. The percentage in this order is 70. The order 4,6,5,7,3,8,2 comes next with 56 per cent, and the order 8,7,6,5,4,3,2 is last, with 41 per cent.

If every series of groups were faster than the series of next-smaller groups, the figures in the right-hand total column of Table 9 would be 21 for each reactor except Reactor *H*, who did no 8-groups in order 2,3,4,5,6,7,8. Nine reactors have a figure at least 2/3 of this,

TABLE 8

RATES IN SECTION III, TAPPING AT ANY CHOSEN REGULAR RATE IN SPECIFIED GROUPS

Figures are average time in seconds per 10 taps. Mean variations are .1 except where indicated in parentheses after a number.

Reactor	Order of groups	Size of group 2	3	4	5	6	7	8
A	2,3,4,5,6,7,8	2.6	2.1	2.8	2.3(.2)	2.1	2.1	2.0
	8,7,6,5,4,3,2	2.4	2.0	2.3	2.5	2.5	2.8(.2)	1.9
B	2,3,4,5,6,7,8	3.4	3.2(.0)	3.2	2.7	2.5	2.4	2.3
	8,7,6,5,4,3,2	3.0(.0)	2.5	3.1	3.2	2.8(.0)	3.9(.0)	2.6
	4,6,5,7,3,8,2	3.0	3.1	2.9	2.8(.0)	2.9	2.7	2.6
C	2,3,4,5,6,7,8	2.5	2.6	2.4	2.3	2.4	2.4	2.3
	8,7,6,5,4,3,2	2.6	2.6(.2)	2.5	2.6	2.6	2.6	2.5
	4,6,5,7,3,8,2	2.5	2.5	2.7	2.5(.0)	2.5	2.4	2.4
D	2,3,4,5,6,7,8	2.7(.0)	3.2	3.2	3.4	2.8	2.7	2.8
	8,7,6,5,4,3,2	2.4	2.4	2.4	2.3	2.4	2.3	2.5(.0)
	4,6,5,7,3,8,2	2.5(.2)	2.5	3.0	3.4(.2)	3.1	2.8(.2)	2.8
E	2,3,4,5,6,7,8	5.8	3.7	3.3	3.1	2.8	2.8	2.8(.0)
	8,7,6,5,4,3,2	2.1	2.2	2.3	2.1	2.3	2.5	2.6
	4,6,5,7,3,8,2	2.5	2.4(.0)	3.7	2.8	3.1	2.8	2.6
F	2,3,4,5,6,7,8	2.6	4.3(.0)	4.0	3.9	4.0	3.8	3.3
	8,7,6,5,4,3,2	2.7	3.6(.0)	3.4	3.2	3.3	2.7	2.8
	4,6,5,7,3,8,2	2.5	2.6	2.7	3.0	2.4	2.7	2.5
G	2,3,4,5,6,7,8	5.4	4.9	5.2	5.1	4.9	4.9(.0)	4.8
	8,7,6,5,4,3,2	4.6	4.7	4.6	4.7	4.8	4.5(.2)	4.9(.2)
	4,6,5,7,3,8,2	5.6(.3)	5.7(.3)	5.7	5.6	5.8	5.6	5.7(.2)
H	2,3,4,5,6,7,8	4.4	3.4	3.1	2.7	2.9	2.8	
	8,7,6,5,4,3,2	3.1	2.6	2.5	2.2	2.0	2.3	2.6
	4,6,5,7,3,8,2	3.1	2.3	3.0	2.8	2.7	3.1	2.1(.0)
I	2,3,4,5,6,7,8	4.0	3.2	4.4	4.4	3.5	3.3	2.9
	8,7,6,5,4,3,2	3.4	4.0	4.1(.0)	4.2	3.1	3.4	3.6
	4,6,5,7,3,8,2	4.1	3.7	3.7	3.7	3.5(.2)	3.4	3.0(.3)
J	2,3,4,5,6,7,8	7.5	5.9(.0)	6.0	6.1	6.0	6.0	6.0
	8,7,6,5,4,3,2	6.0(.4)	6.0(.3)	5.9	5.9(.2)	5.9	6.0(.0)	6.0
	4,6,5,7,3,8,2	7.2	6.5	6.8	6.6	6.8(.0)	6.6	6.6
K	2,3,4,5,6,7,8	4.9	4.6	4.4	4.1	4.1(.0)	4.0	3.8(.0)
	8,7,6,5,4,3,2	3.9	4.0	4.0	4.0	4.9(.0)	4.4	4.7
	4,6,5,7,3,8,2	3.7	3.9	4.0	3.9	3.9(.0)	4.0(.0)	3.8
L	2,3,4,5,6,7,8	3.0	3.2	5.1	1.8	3.6(.5)	4.0(.0)	3.8
	8,7,6,5,4,3,2	6.1	3.8	3.5	2.5	4.0	2.3(.0)	2.5(.0)
	4,6,5,7,3,8,2	5.0	4.2	3.5	3.4	3.0	3.0	3.3

TABLE 9

SECTION III, TAPPING GROUPS AT ANY CHOSEN RATE*

Reactor	3 2	4 3	2	5 4	3	2	6 5	4	3	2	7 6	5	4	3	2	8 7	6	5	4	3	2	Totals	
Order: 2,3,4,5,6,7,8																							
A	1	0	0	1	0	1	1	1	0	1	0	1	1	0	1	1	1	1	1	1	1	15	
B	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	
C	0	1	1	1	1	1	0	0	1	1	0	0	0	1	1	1	1	0	1	1	1	14	
D	1	0	0	0	0	0	1	1	1	0	1	1	1	1	0	0	0	1	1	1	0	11	
E	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	18	
F	0	1	0	1	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	0	14	
G	1	0	1	1	0	1	1	1	0	1	0	1	1	0	1	1	1	1	1	1	1	16	
H	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1							13	
I	1	0	0	1	0	1	1	1	0	1	0	1	1	0	1	1	1	1	1	1	1	15	
J	1	0	1	0	0	1	1	0	0	1	0	1	0	0	1	0	0	1	0	0	1	9	
K	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	Total possible, 246
L	0	0	0	1	1	1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	7	172/246 = 70%
Totals	9	5	7	10	7	11	7	9	7	9	5	9	10	7	9	8	7	9	10	9	8	172	
Order: 8,7,6,5,4,3,2																							
A	1	0	0	1	0	1	1	1	0	1	0	1	1	0	1	1	1	1	1	1	1	15	
B	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	1	1	1	0	1	9	
C	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	7	
D	0	0	0	1	1	1	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0	7	
E	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
F	0	1	0	1	1	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	9	
G	0	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	6	
H	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	1	14	
I	0	0	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	10	
J	0	1	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	6	
K	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2	Total possible, 252
L	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	1	0	1	1	1	16	103/252 = 41%
Totals	4	6	4	6	6	5	4	5	4	6	5	5	7	6	5	3	5	4	4	4	5	103	

TABLE 9 (*continued*)

	Order: 4,6,5,7,3,8,2																					
B	0	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	18	
C	0	0	0	1	0	0	0	1	0	0	1	1	1	1	1	0	1	1	1	1	12	
D	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	0	7	
E	1	0	0	1	0	0	0	1	0	0	1	0	1	0	0	1	1	1	1	0	9	
F	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	1	0	1	1	1	9	
G	0	0	0	1	1	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	6	
H	1	0	1	1	0	1	1	1	0	1	0	0	0	0	0	1	1	1	1	1	13	
I	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18	
J	1	0	1	1	0	1	0	0	0	1	1	0	1	0	1	0	1	0	1	0	1	11
K	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	1	0	8
L	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	18
Totals	6	2	5	8	3	5	5	7	4	6	7	6	8	5	5	6	9	9	10	7	6	129

Total possible, 231
129/231 = 56%

*Comparing each series of groups with each series of smaller groups. For example, reactor *A*'s 3-groups in the first order were faster than his 2-groups; his 4-groups were not faster than his 3- or 2-groups, etc. Numbers in top row indicate group that is being compared with group indicated by number in second row. Number 1 indicates that the series having groups of size indicated by number in top row was faster than series having groups of size indicated by number in second row.

TABLE 10

SECTION III. GROUPING WHILE TAPPING REGULARLY AT ANY CHOSEN RATE*

	Groups																							
	3	4		5			6				7					8						Total	Possible	Per cent of possible
Reactor	2	3	2	4	3	2	5	4	3	2	6	5	4	3	2	7	6	5	4	3	2			
A	2	0	1	1	0	1	1	1	0	1	0	0	1	0	1	2	2	2	2	2	2	22	42	52
B	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	3	46	63	73
C	0	2	2	2	1	1	0	1	1	1	1	1	1	2	2	2	3	2	2	3	3	33	63	52
D	0	0	0	1	1	1	2	1	1	0	3	2	3	2	1	0	1	2	2	1	0	24	63	38
E	2	1	1	3	2	1	1	2	1	1	1	1	2	1	1	1	1	2	2	1	1	29	63	46
F	0	2	0	2	2	0	1	2	3	1	2	3	2	2	0	2	2	3	3	3	0	35	63	56
G	1	1	1	2	1	1	1	1	0	1	2	2	3	2	2	1	2	1	1	1	1	28	63	44
H	3	2	3	3	2	3	2	3	2	3	1	0	2	2	3	1	1	1	1	1	2	41	57	72
I	2	0	1	0	0	1	3	3	2	3	2	3	3	2	2	2	2	3	3	3	2	42	63	67
J	2	1	3	1	1	3	1	0	1	3	1	1	1	0	2	0	1	1	1	0	2	26	63	41
K	1	1	1	2	1	1	0	2	1	1	2	1	1	1	1	2	3	2	2	2	1	29	63	46
L	2	2	2	3	3	3	1	2	1	2	1	2	3	2	2	1	1	1	3	2	2	41	63	65
Totals	17	13	17	22	16	18	15	20	15	19	18	18	24	18	19	17	22	23	25	21	19	396	729	54%
Per cent of possible	49	37	49	63	46	51	43	57	43	54	51	51	69	51	54	49	63	66	71	60	54			

*Comparing rate of each series of groups with rate of each series of smaller groups. Numbers in top row of table indicate size of group of which the rate is compared with the rate of each successive smaller group indicate by the number in the second row. Numbers in body of table indicate how many times the rate of a given series was faster than the rate of the series it is compared with. For example, Reactor *A*, who did two orders, tapped 3-groups faster than 2-groups in both of them; 4-groups faster than 3-groups in none; 4-groups faster than 2-groups in one; etc. All three orders are combined in this table.

in the order 2,3,4,5,6,7,8, showing a relatively strong tendency in this order to tap faster in the larger groups. In the order 8,7,6,5,4,3,2, however, only three reactors have as large a proportion as this. In the order 4,6,5,7,3,8,2, also, only three reactors have as great a proportion as this.

Reactor *L* had a very low proportion in the order 2,3,4,5,6,7,8, but a relatively high one in the other two orders.

The data indicate no constant tendency to tap faster the more elements there are in the group. The order in which the groups are done seems to affect the relationship among the rates. Reactors differed considerably in their tendency, or lack of it, to tap faster in the larger groups; some did not show it at all. The same order was not the most favorable for bringing out the tendency in all reactors.

Section IV. Relative Rates of Different Types of Groups, When Equal Intervals between Taps Were Required, and Reactors Were to Choose a Rate Which Seemed Fast. The 12 reactors of the preceding section took part in this section. There were three sets of instructions. The first was as follows:

> In the series that you are now to do, you are to tap regularly as before, at the same time thinking of the taps as being grouped as specified. The rate you choose may be different for each series if you wish.
>
> The new feature of the tapping is this: You are to tap at such a rate that you feel definitely that you are hurrying, that you are tapping faster than you would had you not been told to hurry.
>
> The following series are to be done in the order given:
>
> | | |
> |---|---|
> | First series: | Groups of 2 |
> | Second series: | Groups of 3 |
> | Third series: | Groups of 4 |
> | Fourth series: | Groups of 5 |
> | Fifth series: | Groups of 6 |
> | Sixth series: | Groups of 7 |
> | Seventh series: | Groups of 8 |

The other two sets of instructions differed from this only in the order in which the different series of groups were done. In the second set the order was groups of 8,7,6,5,4,3,2; in the third, groups of 4,6,5,7,3,8,2. Nine of the 12 reactors did all three sets.

TABLE 11

RATES IN SECTION IV, TAPPING IN GROUPS AT A REGULAR RATE FASTER THAN MOST SATISFACTORY

Figures are average time in seconds per 10 taps. Mean variations are .1 except where indicated in parentheses after a number.

Reactor	Order of groups	Size of group 2	3	4	5	6	7	8
	2,3,4,5,6,7,8	1.8	1.8	1.8(.0)	1.6	1.8(.0)	1.7(.4)	1.7
A	8,7,6,5,4,3,2	1.7	1.6	1.7	1.7	1.8	1.6	1.6
	4,6,5,7,3,8,2	2.3	2.1		1.8	1.9(.0)	1.8	1.8
	2,3,4,5,6,7,8	2.3	2.2	1.9(.0)	2.0	1.8(.0)	1.9	1.7
B	8,7,6,5,4,3,2	1.9	1.8	1.8	1.8	1.8	2.1	2.1
	4,6,5,7,3,8,2	1.7	1.7	1.8	1.9	1.8	1.7	1.7
	2,3,4,5,6,7,8	2.1	2.1	2.0(.0)	2.1	2.0	2.0	2.0
C	8,7,6,5,4,3,2	2.0	2.0	2.0	2.0	2.0(.0)	2.0(.0)	2.1
	4,6,5,7,3,8,2	2.1	2.1	2.0	2.0	2.3	2.0	1.8
	2,3,4,5,6,7,8	2.6(.0)	2.5	2.6	2.4	2.3(.0)		2.5
D	8,7,6,5,4,3,2	2.2	2.6	2.4(.0)	2.8	2.4	2.5	2.5
	4,6,5,7,3,8,2	2.1	2.2	2.3	2.1	2.1	2.4	2.3
E	2,3,4,5,6,7,8	1.9(.0)	1.8(.0)	1.8(.0)	1.8	1.7	1.8(.0)	1.8(.0)
	2,3,4,5,6,7,8	2.0(.0)	2.0	1.9	2.0(.0)	1.8(.0)	1.8(.0)	1.9
F	8,7,6,5,4,3,2	2.0(.0)	1.8	2.0(.0)	1.9	1.9(.0)	2.0	2.0(.0)
	4,6,5,7,3,8,2	1.9	1.9	2.1	2.0	2.0	1.9	1.8(.0)
	2,3,4,5,6,7,8	2.2	2.0	2.0(.0)	2.1	2.0	1.9	2.0
G	8,7,6,5,4,3,2	3.0(.0)	2.6	2.4	2.5	2.3	2.3	2.1(.0)
	4,6,5,7,3,8,2	2.1(.0)	2.2	2.3	2.3(.0)	2.4	2.4	2.2(.0)
H	2,3,4,5,6,7,8	2.4	2.3	1.9(.0)	1.9	1.8(.0)	1.8	1.8(.0)
	8,7,6,5,4,3,2	2.1(.0)	2.0	1.9	1.9	1.9	1.7	1.7
	2,3,4,5,6,7,8	2.2	1.8	1.7	1.8	1.6	1.8	1.8(.0)
I	8,7,6,5,4,3,2	2.1	1.7	1.6(.0)	1.7	1.8	1.8	1.8
	4,6,5,7,3,8,2	2.2	2.0	2.2(.0)	2.0(.0)	2.1	1.9	2.0
	2,3,4,5,6,7,8	3.7(.2)	3.1(.2)	3.4(.2)	2.4	2.7	2.6(.2)	2.6
J	8,7,6,5,4,3,2	3.6	3.5	3.5	3.6	3.7(.2)	3.5	3.2
	4,6,5,7,3,8,2	2.4	2.1	2.6(.0)	2.5	2.7	2.4	2.3
K	8,7,6,5,4,3,2	2.2(.0)	2.2	2.1	2.1(.0)	2.1	2.3	2.1
	4,6,5,7,3,8,2	2.3(.0)	2.2(.0)	2.1	2.1(.0)	2.3(.0)	2.2	2.0(.0)
	2,3,4,5,6,7,8	2.1	1.8	1.8	2.0	1.6	1.7	1.6
L	8,7,6,5,4,3,2	1.7	1.7	2.0	1.7	1.8	1.7	1.9
	4,6,5,7,3,8,2	2.0(.0)	2.0(.0)	1.7	1.6	1.7	1.6	1.7

Table 11 gives the individual rates for each order and each series of groups. Table 12 compares the rate of each series of groups with the rate of each series of smaller groups, for each order separately. Table 13 gives the same comparison for all three orders combined.

Taking the three orders combined (Table 13), there is evident

TABLE 12

SECTION IV, TAPPING GROUPS AT A RATE FASTER THAN MOST SATISFACTORY*

Reactor	3 2	4 3	2	5 4	3	2	6 5	4	3	2	7 6	5	4	3	2	8 7	6	5	4	3	2	Totals	
											Order: 2,3,4,5,6,7,8												
A	0	0	0	1	1	1	0	0	0	0	1	0	1	1	1	0	1	0	1	1	1	11	
B	1	1	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	18	
C	0	1	1	0	0	0	1	0	1	1	0	1	0	1	1	0	0	1	0	1	1	11	
D	1	0	0	1	1	1	1	1	1	1							0	0	1	0	1	10	
E	1	0	1	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	9	
F	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1	0	0	1	0	1	1	13	
G	1	0	1	0	0	1	1	0	0	1	1	1	1	1	1	0	0	1	0	0	1	12	
H	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	17	
I	1	1	1	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	10	
J	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	0	1	0	1	1	1	16	Total possible, 225
L	1	0	1	0	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	16	143/225 = 64%
Totals	8	5	9	3	5	9	9	8	9	10	3	6	6	8	10	2	3	6	6	7	11	143	
											Order: 8,7,6,5,4,3,2												
A	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	1	9	
B	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	
C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
D	0	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	1	0	1	0	7	
F	1	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	5	
G	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	19	
H	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	17	
I	1	1	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	7	
J	1	0	1	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	1	11	
K	0	1	1	0	1	1	0	0	1	1	0	0	0	0	0	1	0	0	0	1	1	9	Total possible, 231
L	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	5	93/231 = 40%
Totals	7	5	6	2	3	6	2	3	4	6	4	5	4	3	5	3	4	5	5	5	6	93	

TABLE 12 (*continued*)

	Order: 4,6,5,7,3,8,2																					
A	1				1	1	0		1	1	1	0		1	1	0	1	0		1	1	**11**
B	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	1	0	0	**7**
C	0	1	1	0	1	1	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	**13**
D	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	**5**
F	0	0	0	1	0	0	0	1	0	0	1	1	1	0	0	1	1	1	1	1	1	**11**
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	**4**
I	1	0	0	1	0	1	0	1	0	1	1	1	1	1	1	0	1	0	1	0	1	**13**
J	1	0	0	1	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	0	1	**10**
K	1	1	1	0	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	**13**
L	0	1	1	1	1	1	0	0	1	1	1	0	1	1	1	0	0	0	0	1	1	13
Totals	4	3	5	5	5	5	1	3	3	3	8	4	5	4	5	6	8	6	7	5	7	100

Total possible, 204
100/204 = 49%

*Comparing each series of groups with each series of smaller groups. To be read in the same way as Table 9.

TABLE 13

SECTION IV, GROUPING WHILE TAPPING AT A RATE FASTER THAN MOST SATISFACTORY*

Reactor	Groups																					Total	Possible	Per cent of possible
	3 2	4 3	2	5 4	3	2	6 5	4	3	2	7 6	5	4	3	2	8 7	6	5	4	3	2			
A	2	0	0	1	2	2	0	0	1	1	3	1	2	2	3	0	3	1	2	2	3	31	57	54
B	2	1	2	1	1	2	2	1	1	2	1	2	1	1	1	1	2	2	2	1	1	30	63	48
C	0	2	2	0	1	1	1	0	1	1	1	1	0	2	2	1	1	2	1	2	2	24	63	38
D	1	1	2	2	2	1	2	2	3	1	0	1	0	1	0	1	1	1	0	1	0	23	57	40
E	1	0	1	0	0	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	9	21	43
F	1	1	1	2	0	1	1	3	1	2	1	2	2	1	1	1	1	2	1	2	2	29	63	46
G	2	1	2	1	1	2	2	1	1	2	1	2	2	2	2	2	2	3	2	1	1	35	63	55
H	2	2	2	0	2	2	1	1	2	2	1	2	2	2	2	0	1	2	2	2	2	34	63	81
I	3	2	2	1	0	3	1	2	1	3	1	1	1	1	3	0	1	0	1	0	3	30	63	48
J	3	0	2	2	1	1	1	1	1	1	3	2	2	1	2	2	3	2	3	2	3	38	63	60
K	1	2	2	0	2	2	0	0	1	1	1	0	0	0	1	2	1	1	1	2	2	22	42	52
L	1	1	2	2	1	2	1	2	2	2	2	1	3	2	2	1	0	1	2	2	2	34	63	34
Totals	19	13	20	12	13	20	13	14	16	19	15	15	15	15	20	11	16	17	17	17	22	339	681	50%
Per cent of possible	59	42	64	38	41	63	41	44	50	59	48	48	48	48	64	38	50	53	53	53	69			

*To be read in the same way as Table 10.

no general tendency under these conditions to tap the larger groups faster. Only four reactors reach or exceed a proportion as large as 1/2, when the number of times the larger groups could have been faster than the smaller is compared with the number of times they actually were faster.

When the different orders are taken separately, and again each series of groups is compared with each series having smaller groups, the larger groups are faster than the smaller in 64 per cent of the cases when the order of groups is 2,3,4,5,6,7,8. The corresponding percentage for the order 4,6,5,7,3,8,2 is 49 per cent, and for the order 8,7,6,5,4,3,2 it is 40 per cent.

If each series were faster than the series of groups next below it in size, the figures in the "total" column at the right of Table 12 would be 21 (except for Reactor *D* in Order 1, and Reactor *A* in Order 3). When the order was 2,3,4,5,6,7,8, only five reactors had a figure as large as 2/3 of that (including Reactor *D* with 10 out of 15 possible). When the order was 8,7,6,5,4,3,2, only two reactors had as large a proportion as this, and the percentage for the group as a whole was only 40 per cent. In the order 4,6,5,7,3,8,2, only Reactor *A* had a proportion as high as 2/3, with 11 out of 15 possible. The percentage for the group as a whole in this order was 49.

Under these conditions, as under those in the preceding section, reactors who tended to tap larger groups faster in one order did not do so in another, in many cases. In no order was the tendency shown by all reactors, and the same order was not the most favorable for all.

The 8-groups were faster than 2-groups in 69 per cent of the cases. When each series of groups is compared with each series of smaller groups, for all three orders combined, this is the highest percentage. In only 9 of 21 such comparisons does the percentage exceed 50; 4 of these are comparisons of 8-groups with smaller groups, and the other 5 are comparisons of 2-groups with larger groups. Apparently 2-groups tended to be slowest and 8-groups faster. Only five reactors reach or exceed a proportion as large for the 8-groups, however, the percentages are not much above 50 in all comparisons except that with the 2-groups.

Section V. Relative Rates of Different Types of Groups, When Equal Intervals between Taps Were Required, and Reactors Could

Choose Any Rate But Were to Count Groups Only, Instead of Individual Taps. Nine reactors, all from the preceding section took part in this one. The instructions were as follows:

> You are to tap at a regular rate, with intervals between taps equal. Choose any rate you wish for any series. You will be asked to tap a definite number of groups for each series. This means that you will not count each tap, but will count only the groups. The groups will consist of a specified number of elements as before. For example, you will be asked to count 50 2-groups; this means that after you have tapped 50 groups 2 taps each you will be expected to stop tapping.
>
> Tap the following series in the order given below:
>
> | | |
> |---|---|
> | First series: | 50 groups of 2 |
> | Second series: | 33 groups of 3 |
> | Third series: | 25 groups of 4 |
> | Fourth series: | 20 groups of 5 |
> | Fifth series: | 17 groups of 6 |
> | Sixth series | 15 groups of 7 |
> | Seventh series: | 13 groups of 8 |
>
> Try definitely to count only the groups; do not worry about any defect doing so may have upon your performance.

There were three sets of instruction, differing only in the order in which the different groups were done. In the second set the order of groups was 8,7,6,5,4,3,2; in the third, 4,6,5,7,3,8,2. Seven reactors did all three sets; one did two sets, and the other did one set.

These instructions were used with the hope that by them the group as a unit would be emphasized. There might be no limit to the size of group that could be achieved to the reactor's satisfaction by merely counting 1, 2, 3, 4, and so on, up to almost any number. If counting individual movements were eliminated as an aid to grouping, other factors might determine the limits of the duration of the group. A possible tendency for groups to fall within relatively constant time limits might appear in this case where it would not in the other.

Several reactors stated that they were unable to group successfully under these conditions, and fell back on counting. It was especially difficult to avoid counting when the groups were larger. All reactors counted occasionally. The reactors who stated that they were able to avoid counting most of the time were Reactors

C, D, H, K, and *L.* Those who counted most of the time were Reactors *A* and *B.* Reactor *I* counted all the time. Reactor *G* did not count, but found it impossible to maintain the desired groupings, and stated that he felt completely lost in most of the series.

TABLE 14

RATES IN SECTION V, COUNTING THE GROUPS ONLY, TAPPING AT ANY CHOSEN RATE

Figures are average time in seconds per 10 taps. Mean variations are .1 except where indicated in parentheses after a number.

Reactor	Order of groups	Size of group 2	3	4	5	6	7	8
	2,3,4,5,6,7,8	2.8	3.0(.3)	2.1	1.9(.0)	1.9	1.8	1.8
A	8,7,6,5,4,3,2		2.2	2.0	1.9(.0)	1.9(.0)	2.0(.0)	1.9
	4,6,5,7,3,8,2	2.7(.2)	2.4	1.9	2.0	2.0(.0)	1.9	1.9
	2,3,4,5,6,7,8	2.1(.0)	1.9	1.7(.0)	1.8	1.7	1.7	1.7
B	8,7,6,5,4,3,2	2.0(.2)	2.1(.3)	1.8	2.1(.2)	1.9	1.9(.2)	1.9
	4,6,5,7,3,8,2	2.1(.2)	2.0(.2)	2.1	1.9	1.9	1.9	1.8
C	2,3,4,5,6,7,8	2.0	2.7(.2)	2.2	2.2	1.9	1.9	2.2(.2)
	8,7,6,5,4,3,2	2.1(.2)	2.5(.2)	2.5(.3)	2.1	2.2(.2)	2.1(.2)	2.1
	2,3,4,5,6,7,8	2.7	2.5	3.0	3.1	2.6	3.0	3.0(.2)
D	8,7,6,5,4,3,2	2.6	2.5	2.7	2.5	2.5	2.5	2.3
	4,6,5,7,3,8,2	2.9	2.9(.2)	2.5	3.5	2.4	3.1	2.6
	2,3,4,5,6,7,8	2.6	2.9	2.9	2.6	2.4(.0)	2.5	2.5(.0)
G	8,7,6,5,4,3,2	3.2	3.0	3.7	2.7	3.9	3.1(.0)	2.5
	4,6,5,7,3,8,2	2.6(.0)	3.0(.0)	2.7	2.4	2.5	2.3	2.5
H	2,3,4,5,6,7,8	2.6	2.4	2.3	2.1	2.1(.0)	2.3	2.1
	2,3,4,5,6,7,8	2.5	1.9	1.6	2.0	1.6(.0)	1.7(.0)	1.7
I	8,7,6,5,4,3,2	2.1	2.5	1.8	1.8	1.8(.0)	2.0	1.8
	4,6,5,7,3,8,2	2.3(.0)	2.3	2.1	2.3	2.2	2.1	1.9
	2,3,4,5,6,7,8	3.2	3.1(.0)	2.8(.0)	2.9	2.9	2.6	2.6(.0)
K	8,7,6,5,4,3,2	2.8	2.8	2.7	2.8	2.8	3.0(.0)	2.9
	4,6,5,7,3,8,2	2.6	2.6(.0)	2.8	2.9	2.9(0)	2.7(.0)	2.5
	2,3,4,5,6,7,8	5.8(.3)	6.3	5.6	5.7	5.3	5.1	5.1
L	8,7,6,5,4,3,2	6.8	4.0	3.4(.0)	3.3	2.6	3.0	3.2(.0)
	4,6,5,7,3,8,2	4.5	3.8	4.0	3.9	3.7	3.8	5.0

Table 14 gives the individual rates for each order and each series of groups. Table 15 compares the rate of each series with the rate of each series of smaller groups, for each order separately. Table 16 gives the same comparison for all three orders combined.

Table 16, the three orders combined, indicates a greater tendency under these conditions to tap faster when the groups are larger, than appeared in either of the preceding two sections. The percentage of larger groups faster than smaller for the groups as a

TABLE 15

SECTION V, TAPPING GROUPS AT ANY RATE, COUNTING ONLY THE GROUPS*

	3	4		5			6				7					8						
Reactor	2	3	2	4	3	2	5	4	3	2	6	5	4	3	2	7	6	5	4	3	2	Total
Order: 2,3,4,5,6,7,8																						
A	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	18
B	1	1	1	0	1	1	1	0	1	1	0	0	0	1	1	1	0	1	0	1	1	14
C	0	1	0	0	1	0	1	1	1	1	0	1	1	1	1	0	0	0	0	1	0	11
D	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	6
G	0	0	0	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	14
H	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	0	1	1	1	15
I	1	1	1	0	0	1	1	0	1	1	0	1	0	1	1	0	0	1	0	1	1	13
K	1	1	1	0	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	17
L	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	18
Totals	5	7	6	3	7	6	6	6	8	9	3	7	5	8	8	2	3	7	5	8	7	126
Order: 8,7,6,5,4,3,2																						
A		1		1	1		0	1	1		0	0	0	1		1	0	0	1	1		9
B	0	1	1	0	0	0	1	0	1	1	0	1	0	1	1	0	0	1	0	1	1	11
C	0	0	0	1	1	0	0	1	1	0	1	0	1	1	0	0	1	0	1	1	0	10
D	1	0	0	1	0	1	0	1	0	1	0	0	1	0	1	1	1	1	1	1	1	13
G	1	0	0	1	1	1	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	13
I	0	1	1	0	1	1	0	0	1	1	0	0	0	1	1	1	0	0	0	1	1	11
K	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
L	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	18
Totals	3	5	4	5	5	4	2	4	5	4	2	2	4	5	5	5	3	4	5	7	5	88
Order: 4,6,5,7,3,8,2																						
A	1	1	1	0	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	1	1	15
B	1	0	0	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	16
D	0	1	1	0	0	0	1	1	1	1	0	1	0	0	0	1	0	1	0	1	1	11
G	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	15
I	0	1	1	0	0	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	15
K	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	1	1	1	9
L	1	0	1	1	0	1	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	11
Totals	3	4	4	3	3	4	3	4	6	6	4	6	4	4	5	4	4	5	4	6	6	92

Total possible, 189
126/189 = 67%

Total possible, 162
88/162 = 54%

Total possible, 147
92/147 = 62%

*Comparing rate of each series of groups with each series of smaller groups. To be read in the same way as Table 9.

whole is 61. Seven of the reactors exceed 50 per cent, five of them exceed 67 per cent.

When the orders are taken separately (Table 15), the order 2,3,4,5,6,7,8 has as before the highest percentage (67 per cent) for the group as a whole. Comparing the figures in the right-hand "total" column with 21, which would be the figure (except for Reactor *A* in order 8,7,6,5,4,3,2) if each series of groups were faster than the series of next-smaller groups, shows that seven of the nine reactors have proportions greater than 1/2, and six of them a proportion as great or greater than 2/3.

When the order is 8,7,6,5,4,3,2, the percentage for the group as a whole drops to 54. Six reactors exceed 1/2, but only one reaches 2/3.

In the order 4,6,5,7,3,8,2, the percentage for the group as a whole is 62. The proportion of "total" cases to "possible" cases is as great as or greater than 2/3 for four reactors.

The three orders occupy the same relative positions in this section as in the preceding two sections.

Taking all orders combined, Table 16, bottom row, shows that 14 of the 21 comparisons between each series of larger groups and each series of smaller groups yield percentages greater than 50. Seven of them are above 67 per cent. Eight-groups compared with 3-groups show the highest percentage (87 per cent); 8-groups compared with 2-groups and 6-groups compared with 2-groups have 83 per cent and 82 per cent respectively.

These data suggest, taking the reactors as a whole, a greater tendency to tap the larger groups faster, when only groups and not individual taps were to be counted. This does not hold for each reactor, however. Table 17 shows this; it gives for each reactor in each of the three sections, III, IV, and V, the percentage of cases in which his larger groups were faster than the smaller.

Section VI. Comparison of the Absolute Rates Chosen Under the Various Conditions. Table 18 shows the distribution of the rates tapped by the various reactors in ungrouped and grouped series, when they chose their own rates. It also shows, for comparison, the distribution of the rates of the "faster" grouped series. Since the rates seem to have been to a considerable extent independent of the type of grouping, it is of interest to compare the rates chosen in the grouped series with the rates chosen when there was no grouping

TABLE 16

SECTION V, COUNTING GROUPS ONLY, TAPPING AT ANY CHOSEN RATE*

Reactor	Groups 3 2	4 3	2	5 4	3	2	6 5	4	3	2	7 6	5	4	3	2	8 7	6	5	4	3	2	Total	Possible	Per cent of possible
A	1	3	2	2	3	2	0	2	3	2	2	2	1	3	2	1	2	2	2	3	2	42	57	74
B	2	2	2	1	2	2	2	1	3	3	0	1	1	3	3	2	1	3	2	3	3	42	63	67
C	0	1	0	1	2	0	1	2	2	1	1	1	2	2	1	0	1	0	1	2	1	22	42	52
D	2	1	1	1	0	1	2	3	1	3	0	2	1	0	1	1	1	3	1	2	2	29	63	46
G	1	1	0	3	3	2	1	2	2	2	2	2	3	2	3	1	1	2	3	3	3	42	63	67
H	1	1	1	1	1	1	0	1	1	1	0	0	0	1	1	1	0	0	1	1	1	15	21	70
I	1	3	3	0	1	2	2	1	3	3	1	2	0	3	3	2	1	2	1	3	3	39	63	62
K	1	2	2	0	1	1	0	0	1	1	2	2	2	1	1	2	2	2	2	2	2	29	63	46
L	2	2	3	2	2	3	3	3	3	3	1	3	2	2	3	0	1	1	2	2	2	45	63	71
Totals	11	16	14	11	15	14	11	14	19	19	9	15	12	17	18	10	10	15	15	21	19	305	498	61%
Per cent of possible	48	67	61	46	63	61	46	58	79	82	37	63	50	71	70	42	42	63	63	87	83			

*To be read in the same way as Tables 10 and 13.

TABLE 17

SHOWING PERCENTAGE OF CASES IN WHICH LARGER GROUPS WERE FASTER THAN SMALLER GROUPS, FOR EACH OF THE THREE SECTIONS, III, IV, AND V, FOR EACH REACTOR

Reactor	III	IV	V
A	52	49	74
B	73	48	67
C	52	38	52
D	38	39	46
E	46	43	—
F	56	46	—
G	44	55	67
H	72	81	70
I	67	48	62
J	41	60	—
K	46	52	46
L	63	34	71

called for. In general, the rates showed less scatter when the taps were grouped. This was not necessarily the result of grouping, however; the series in which the taps were grouped came relatively late in the course of the work, and the preceding practice in tapping may have tended to establish a more definite preference.

In all three sections, I, III, and V, rates of 2 to 3 sec. per 10 taps were chosen with the greatest frequency, with rates of 3 to 4 sec. per 10 taps next. Reactor *C, E, G, I,* and *J,* who tended to choose slower rates than these in their initial, ungrouped series, and who also initially chose a wider range of rates in general, all moved close to the modal rate in their later, grouped series. Although all reactors did not do the same number of series, the preponderance of rates in the intervals 2 to 3 sec. and 3 to 4 sec. per 10 taps is impressive.

Inspection of the rows labelled IV in Table 18 will show that every reactor tended to tap faster in his "faster" grouped series than in his "most satisfactory" ungrouped or grouped series, although there is a considerable amount of overlapping. The only doubtful case in the table is Reactor C, with 21 out of 21 series in the interval 2 to 3 sec. per 10 taps in his "most satisfactory" grouped series, and 20 out of 21 in the same interval in his "faster" grouped series. If these intervals were subdivided into half-second intervals, it would be seen that the 20 cases in the "faster" series were all at rates between 2.0 and 2.4 sec. per 10 taps, while 14 of the 21 cases

TABLE 18

DISTRIBUTION OF RATES UNDER FOUR DIFFERENT CONDITIONS

Reactor	Section	Type	Rate in seconds per 10 taps													
			1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	Total
A	I	U		18	1		2		1								22
	III	G	1	13													14
	IV	FG	18	2													20
	V	CG	12	7	1												20
B	I	U		2	20												22
	III	G		12	9												21
	IV	FG	16	5													21
	V	CG	14	7													21
C	I	U		5	8	1			1	6	1						22
	III	G		21													21
	IV	FG	1	20													21
	V	CG	2	12													14
D	I	U		22													22
	III	G		15	6												21
	IV	FG		21													21
	V	CG		15	6												21
E	I	U				6	7	3	3	1	1	1					22
	III	G		15	5		1										21
	IV	FG	7														7
	V	CG															0
F	I	U		5	5	3	4	3									20
	III	G		10	8	3											21
	IV	FG	11	10													21
	V	CG															0
G	I	U						5	7	3	2	2	1				20
	III	G				11	10										21
	IV	FG	1	19	1												21
	V	CG		15	6												21

TABLE 18 (*continued*)

Reactor	Section	Type	Rate in seconds per 10 taps														
			1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	Total
H	I	U		1	14	2	1										18
	III	G		13	6	1											20
	IV	FG	9	5													14
	V	CG		7													7
I	I	U				1	7	6	1		1						16
	III	G		1	13	7											21
	IV	FG	13	8													21
	V	CG	10	11													21
J	I	U								1		2		1	5	1	10
	III	G				4	15	2									21
	IV	FG		11	10												21
	V	CG															0
K	I	U															0
	III	G			1	6											7
	IV	FG		14													14
	V	CG		18	3												21
L	I	U															0
	III	G	1	3	11	3	2	1									21
	IV	FG	16	5													21
	V	CG		1	8	3	7	2									21
Totals	I	U	0	53	48	13	21	17	13	11	5	5	1	1	5	1	194
	III	G	2	103	59	31	17	16	2								230
	IV	FG	92	120	11												223
	V	CG	38	93	24	3	7	2									167

I U—Section I, ungrouped tapping.
III G—Section III, grouped tapping at any chosen rate.
IV FG—Section IV, grouped tapping, "faster" rate.
V CG—Section V, counting only the groups.

of the "most satisfactory" grouped series were at rates between 2.5 and 2.9 sec. per 10 taps.

The rows in Table 18 which are labelled V, in which the rates are given for the series in which only the groups were to be counted, when compared with the rows labelled III, which give the rates in the series where any rate could be chosen and there was no restriction on counting, show that Reactors *A, B, G, I,* and *K* tended to tap faster under the former conditions than under the latter. This may have been due to the increased difficulty of the former task (most reactors reported that they found it very difficult), or to some actual change in the nature of the groups. In the case of Reactors *A, I,* and *K* it seems to have been the result of a greater tendency to tap faster in the larger groups; in the case of the other two reactors, to a general increase in speed throughout.

Summary and Conclusions

1. Reactors were first instructed to tap regularly upon a key at a rate that seemed most satisfactory to them. This task sometimes followed the performance of a rate which seemed fast, sometimes followed the performance of a rate which seemed slow, and sometimes preceded one or the other of these. Under these conditions:

a. Certain reactors showed much less variation in the rates they chose as most satisfactory from time to time than others did. If the rates tapped were grouped into intervals of 1 sec. per 10 taps, three types of reactors could be roughly distinguished: those whose rates all fell within an interval of 1 or 2 sec., those whose range was wider but who had a decided mode in some one interval, and those whose range was wide and who had no very decided mode.

b. The rates chosen varied from between 1 and 2 sec. per 10 taps to between 14 and 15 sec. per 10 taps. No one reactor tapped rates which covered this whole range, and in this sense each reactor had his own preferred range of rate.

c. There was evidence that in some cases the immediately preceding performance had a predictable effect upon the "most satisfactory" rate.

2. Reactors were then instructed to tap and to group their taps into groups of varying numbers of elements. Variations were

introduced into the conditions under which this was done. Under these conditions:

a. The range of rates chosen diminished. All reactors tended more to choose rates in the same range. This was due mainly to increased speed upon the part of previously slower reactors.

b. No decisive evidence was found, in the tapping of groups under four different conditions, of a constant tendency to tap faster in the larger groups than in the smaller.

c. The order in which the different types of grouping followed one another seemed to influence the tendency in some cases.

d. When counting of individual movements was prohibited, the tendency was greater to make the larger groups faster.

e. Even when the larger groups were tapped faster than the smaller, the difference in rate was not great enough to make the groups of anywhere nearly equal duration. Preference for rate appeared to be based on the rate of succession of individual taps rather than on duration of group.

f. The shortest 2-groups were at the rate of 1.6 sec. per 10 taps, making the duration of that group 0.32 sec. The longest 8-groups tapped were at the rate of 6.6 sec. per 10 taps, making the groups 5.3 sec. in duration. These were the shortest and the longest groups that occurred.

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